Cancer incidence and mortality around the Pan Britannica Industries pesticide factory, Waltham Abbey

P Wilkinson, B Thakrar, G Shaddick, S Stevenson, S Pattenden, M Landon, C Grundy, P Elliott
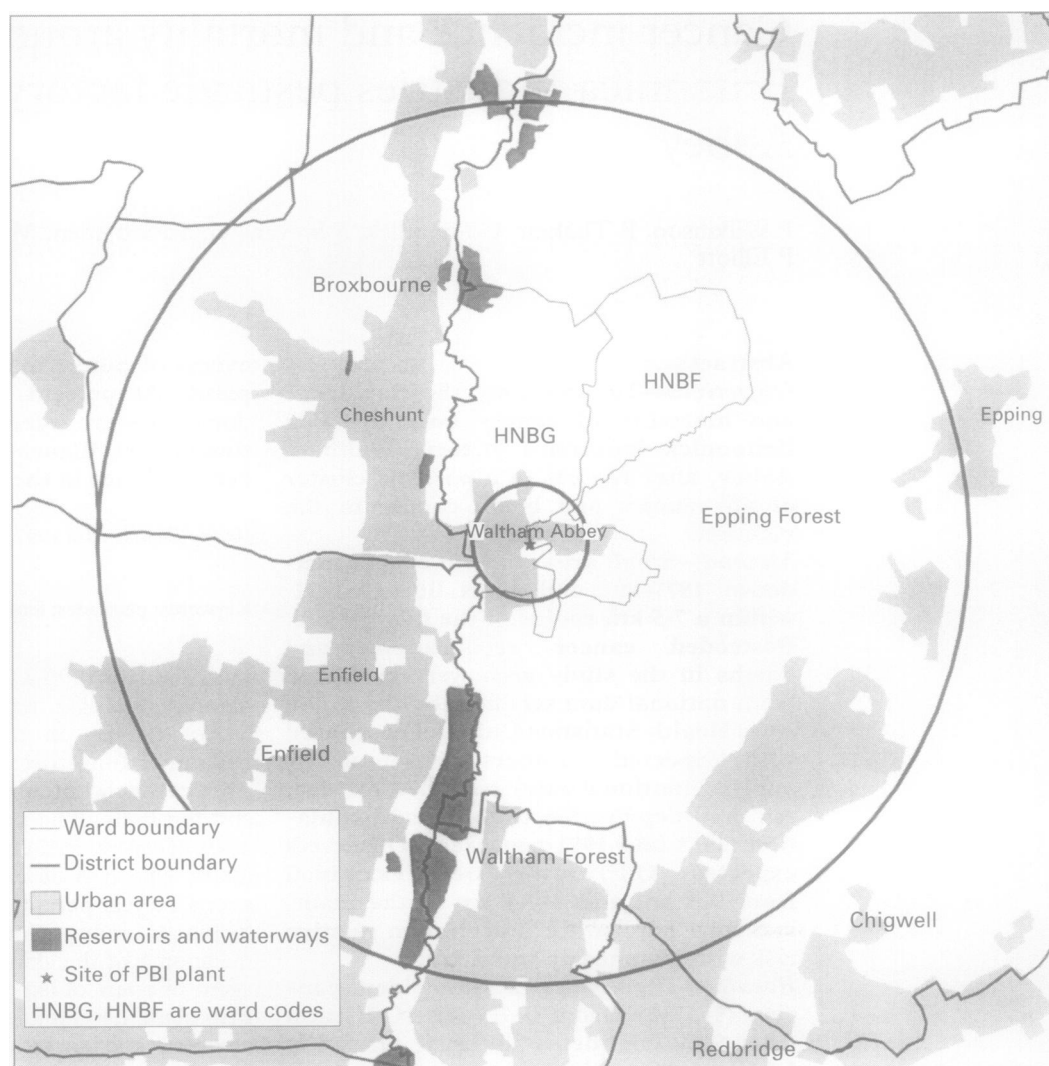
Small Area Health
Statistics Unit, London
School of Hygiene and
Tropical Medicine,
Keppel Street, London,
WC1E 7HT
P Wilkinson
B Thakrar
S Stevenson
S Pattenden
M Landon
C Grundy

Department of
Epidemiology and
Public Health,
Imperial College
School of Medicine at
St Mary's, Norfolk
Place, London,
W2 1PG
G Shaddick
P Elliott

Correspondence to:
Dr P Wilkinson, Department
of Public Health and Policy,
London School of Hygiene
and Tropical Medicine,
Keppel Street, London,
WC1E 7HT.

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Abstract

Objectives—To examine the incidence and mortality of cancer near the Pan Britannica Industries factory, Waltham Abbey, after reports of a possible cluster of all cancers and brain cancer in the vicinity.

Method—Small area study of cancer incidence 1977–89, and mortality 1981–92, within a 7·5 km radius of the factory site. Postcoded cancer registrations and deaths in the study area were extracted from national data sets held by the Small Area Health Statistics Unit and compared with expected numbers computed by applying national rates stratified for age, sex, and deprivation to the local population (1981 and 1991 censuses). Observed/expected (O/E) ratios were examined from 0–1 km and 0–7·5 km of the plant, and tests applied for a decline in relative risk with distance up to 7·5 km.

Results—There were 12 859 incident cancers (1977–89) from 0–7·5 km (O/E ratio 1·04; 95% confidence interval (95% CI) 1·02 to 1·06) and 385 from 0–1 km (O/E 1·10; 1·00 to 1·22). There was an excess of skin melanoma from 0–1 km based on 11 cases (O/E 2·13; 1·06 to 3·80), and an excess from 0–7·5 km of cancer of the lung, stomach and pancreas combined, and prostate (O/Es ranged from 1·09 to 1·13). Only the findings from lung cancer were suggestive of a decline in risk with distance, especially in the later period (1982–9). There were 9196 cancer deaths (1981–92) from 0–7·5 km (O/E 1·04; 95% CI 1·02 to 1·06) and 308 from 0–1 km (O/E 1·24; 1·11 to 1·39); and 25 507 non-cancer deaths (O/E 1·02; 1·01 to 1·04) from 0–7·5 km and 745 (O/E 1·14; 1·06 to 1·22) from 0–1 km. There was evidence of a decline in mortality with distance for all cancers combined, lung cancer (P = 0·001 for each), and colorectal cancer (P < 0·05), and also for non-cancers (P = 0·001). Proportional mortality analyses suggested a decline in risk with distance for lung cancer (P = 0·003) but not for all cancers or the site specific cancers examined. There was no evidence of an excess in the incidence or mortality from brain cancer. For cancer mortality in the innermost wards, the findings were, for the most part, well within the range of variation across the region as a whole.

Conclusions—The study provides limited and inconsistent evidence for a localised excess of cancer in the vicinity of the PBI plant. At present, further investigation does not seem warranted other than continued surveillance of mortality and cancer incidence in the locality.

On 7 January 1993 a Carlton Television documentary, *Storyline*, reported an apparent cluster of cancers in the vicinity of the Pan Britannica Industries (PBI) plant in Waltham Abbey[1] which formulates a range of pesticides and fertilisers. The programme discussed the cases of several PBI employees and nearby residents who had developed or died of cancer over a 10 year period. The specific cancer sites included brain, colon, lung, pancreas, and melanoma of the skin. Although no causative agent or route of exposure was suggested, the PBI plant has handled possible human carcinogens and an informal analysis of cancer mortality carried out for the programme suggested that there had been more deaths than expected from national rates among the workforce and including three unconfirmed cases of brain cancer over 10 years among residents who lived in a road bordering the plant. The documentary therefore raised concerns but did not offer specific hypotheses.

This report gives the results of a formal epidemiological investigation undertaken by the Small Area Health Statistics Unit (SAHSU)[2 3] into cancer incidence and mortality in the vicinity of the PBI plant.

Methods

The site of the study was the PBI plant in Waltham Abbey, Essex, EN9 1NP, located just outside the M25 motorway north east of London and east of the housing and industrial development along the Lea valley (fig 1). The population density in surrounding areas is highest to the south and west. Based on census information for 1981 enumeration districts, the Waltham Abbey area seems to be less socioeconomically deprived than the average for England and Wales as a whole, and there is little change in deprivation with distance from the plant.

The Ordnance Survey (OS) grid reference used for the factory site, 1538500 east, 1200300 north, is a node of an OS 100 m grid network lying within the boundary of the site

Figure 1   Circles of 1 and 7·5 km around the PBI plant, Waltham Abbey.

to the east of the A112 road. An area within 1 km of this point was chosen at the outset as having potentially the highest exposure to emissions from the plant. Over 250 chemical agents have been handled at the plant (list provided by the company) but there was no substantive evidence to suggest a putative agent or route of exposure. It was therefore assumed that exposure and risk were highest close to the plant and declined at some (unspecified) distance from it. The risk of cancer was examined in eight concentric bands up to 7·5 km from the site with outer limits at 1, 2, 3, 4·3, 5·3, 6·1, 6·8, and 7·5 km.

Population counts by band were estimated from census small area statistics that used the 1981 census up to and including 1986, and the 1991 census thereafter. Expected (E) numbers of deaths or cancer registrations were calculated by year and band with England and Wales rates stratified by five-year age group, sex, and quintile of the enumeration district Carstairs deprivation index[4] (1981 and 1991 censuses as appropriate). These were further adjusted for disease specific standardised regional registration ratios.[5]

Formal tests of hypotheses were based on the Stone's maximum likelihood ratio test.[6 7] Both unconditional and conditional tests were performed.[8 9] The null hypothesis for the unconditional test, that the relative risk in each band is equal to one, is rejected if the relative risk is higher or lower than one over the study area as a whole or if it declines with distance. The conditional test is specifically for trend as it corrects for the overall level of risk by setting the condition that the sum of expected numbers over the 7·5 km area is equal to the sum of the observed (O) cases. Proportional mortality (PMR) analyses were also carried out with non-cancer deaths to obtain expected values.[10]

The following diagnostic groups of the 8th and 9th revisions of the International Classification of Diseases (ICD-8 and ICD-9) were examined: (*a*) all cancers combined excluding non-melanoma cancer of the skin (140 to 208, excluding 173 and ICD-9 238·6); (*b*) brain tumours, malignant (191 and 192) and combined with benign and unspecified brain tumours (191, 192, 225, 237·5, 237·6, 237·9); (*c*) cancer of the trachea, bronchus, and lung (162); (*d*) pancreatic cancer alone (157) and combined with stomach (151); (*e*) melanoma of the skin (172).

Brain cancer was of particular interest because of the three unconfirmed cases reported in the original television documentary. Separate analyses were carried out by cancer site, age group (0–14, 15–64, and ⩾ 65), and sex.

PERIODS OF STUDY

The periods of study were constrained by the availability and quality of postcoded data.

Incidence

The Small Area Health Statistics Unit cancer registration data covered the period 1974–89. The completeness of registration in North East Thames Region throughout this period is unknown, but a year by year comparison of the number of registrations in each census district within the region with the number expected from the rates for England and Wales indicated relative underreporting in several districts, including Enfield, Epping Forest, Waltham Forest, and Redbridge which contain or adjoin the PBI site (fig 1). Disparities were generally greatest for the years 1974–6, and it was decided at the outset to exclude these three years from the study, although this was an arbitrary cut off point. Hence, the analysis was confined to the years 1977–89. To include a period of investigation independent of the television documentary, the study period was divided into 1977–81 (the years before the time covered by the documentary) and 1982–9.

Mortality and proportional mortality ratios

Mortality analyses (including proportional mortality) were carried out with data for 1981 to 1992, as postcoded mortality data for earlier years are not available.

CANCER MORTALITY IN THE NORTH EAST THAMES REGION

A geographical analysis of variation of cancer mortality across the 601 electoral wards in the North East Thames Region was also carried out to help place in context the results for the study area. Variation in all cancers, lung cancer, and cancer of the stomach and pancreas combined was examined. Observed and expected cancer deaths (adjusted for age, sex, and deprivation) were computed with 1981–6 mortality data for 1981 wards, and 1987–91 data for 1991 wards. With a geographical information system, each 1991 ward was linked to the 1981 ward with the greatest overlap in area, so that their results could be combined. Empirical Bayesian methods[11-13] were used to smooth ward O/E ratios towards the overall mean to reduce the random component of variability in them due to small population sizes. Raw and smoothed O/E ratios for the 601 wards were ranked to show the specific rankings of the two wards, HNBG and HNBF, which together contain 96% of the population within 1 km of the PBI plant (fig 1).

Results

Results are given here for all ages, both sexes combined. Age and sex specific results are available on request. Tables 1 and 2 show results for cancer incidence and tables 3 and 4 show mortality.

CANCER INCIDENCE

From 1977–89, there were 12 859 cancers from 0–7·5 km (O/E ratio 1·04; 95% confidence interval (95% CI) 1·02 to 1·06) and 385 from 0–1 km (O/E 1·10; 1·00 to 1·22, table 1). Both sexes and both the 15–64 and the $\geq$ 65 age groups contributed to this overall excess (not shown). Examination of data over the eight bands (table 2), together with the combination of Stone's tests, did not indicate a decline in risk of all cancers with distance from the site (P = 0·001 unconditional test, P = 0·35 conditional test).

There was no evidence of an excess in the incidence of brain neoplasms (tables 1 and 2). Of the other site specific cancers studied, there was an excess of skin melanoma from 0–1 km based on 11 cases (O/E 2·13; 1·06 to 3·80), and an excess from 0–7·5 km for cancer of the lung, and stomach and pancreas combined, (O/Es ranging from 1·09 to 1·13). For lung

Table 1   Incidence: observed and expected* cancer registrations in the study area: all ages, both sexes

Cancer	0 to 1 km			1 to 7·5 km			Stone's tests P values	
	O	E	O/E (95% CI)	O	E	O/E (95% CI)	Unconditional	Conditional
1977–89:								
All cancers	385	348·7	1·10 (1·00 to 1·22)	12859	12392·0	1·04 (1·02 to 1·06)	0·001	0·35
Brain neoplasm†	4	8·4	0·48 (0·13 to 1·22)	266	281·7	0·94 (0·83 to 1·06)	0·74	0·94
Stomach and pancreatic	32	31·0	1·03 (0·70 to 1·45)	1225	1126·9	1·09 (1·03 to 1·15)	0·04	0·74
Lung	82	68·0	1·21 (0·96 to 1·50)	2792	2471·5	1·13 (1·09 to 1·17)	0·001	0·06
Skin melanoma	11	5·2	2·13 (1·06 to 3·80)	189	168·7	1·12 (0·97 to 1·29)	0·11	0·16
Colorectal	51	41·8	1·22 (0·91 to 1·60)	1560	1527·5	1·02 (0·97 to 1·07)	0·14	0·10
Prostate	25	18·3	1·37 (0·89 to 2·02)	753	684·7	1·10 (1·02 to 1·18)	0·06	0·53
Breast (female)	51	49·3	1·04 (0·77 to 1·36)	1695	1689·7	1·00 (0·96 to 1·05)	0·98	0·83
1977–81:								
All cancers	117	116·4	1·00 (0·83 to 1·20)	4698	4253·5	1·10 (1·07 to 1·14)	0·001	0·98
Brain neoplasm†	2	2·9	0·68 (0·08 to 2·47)	81	99·7	0·81 (0·65 to 1·01)	0·001	0·92
Stomach and pancreatic	7	11·0	0·63 (0·26 to 1·31)	433	413·2	1·05 (0·95 to 1·15)	0·47	0·87
Lung	20	24·4	0·82 (0·50 to 1·26)	1030	916·7	1·12 (1·06 to 1·19)	0·001	0·82
Skin melanoma	3	1·4	2·22 (0·46 to 6·49)	69	45·3	1·52 (1·19 to 1·93)	0·01	0·68
1982–9:								
All cancers	268	232·3	1·15 (1·02 to 1·30)	8161	8138·4	1·00 (0·98 to 1·02)	0·1	0·05
Brain neoplasm†	2	5·5	0·37 (0·04 to 1·32)	185	182·0	1·02 (0·88 to 1·17)	0·88	0·73
Stomach and pancreatic	25	20·1	1·25 (0·81 to 1·84)	792	713·7	1·11 (1·03 to 1·19)	0·02	0·38
Lung	62	43·6	1·42 (1·09 to 1·82)	1762	1554·8	1·13 (1·08 to 1·19)	0·001	0·01
Skin melanoma	8	3·8	2·09 (0·90 to 4·12)	120	123·4	0·97 (0·81 to 1·16)	0·23	0·13

*Expected cases adjusted for age, sex, socioeconomic deprivation, and regional standardised registration ratio.
†Malignant, benign, and unspecified tumours of the central nervous system.

Table 2   Incidence of selected cancers by distance from the PBI plant, 1977–89: all ages, both sexes

Outer radius of band (km)	All cancers		Brain neoplasms*		Stomach and pancreas		Lung		Melanoma skin		Prostate	
	O	O/E†	O	O/E	O	O/E	O	O/E	O	O/E	O	O/E
1	385	1·10	4	0·48	32	1·03	82	1·21	11	2·13	25	1·37
2	407	1·05	6	0·67	31	0·89	114	1·40	4	0·81	23	1·09
3	992	1·02	23	0·97	102	1·18	240	1·17	11	0·85	51	0·98
4·3	1677	1·03	35	0·89	164	1·13	380	1·15	24	1·08	75	0·88
5·3	1415	0·95	39	1·09	148	1·11	335	1·10	25	1·22	53	0·67
6·1	2104	1·09	38	0·86	179	1·02	424	1·15	33	1·18	143	1·30
6·8	3088	1·06	62	0·99	303	1·12	618	1·06	41	1·07	204	1·25
7·5	2791	1·02	59	1·01	266	1·06	599	1·13	40	1·09	179	1·15
Stone's tests P values:												
Unconditional		0·001		0·74		0·04		0·001		0·11		0·06
Conditional		0·35		0·94		0·74		0·06		0·16		0·53

*Malignant, benign, and unspecified tumours of the central nervous system.
†Observed/expected ratio adjusted for age, sex, socioeconomic deprivation, and regional standardised registration ratio.

Table 3   Mortality: observed and expected cancer and non-cancer deaths in the study area: all ages, both sexes*

Cause	0 to 1 km			1 to 7·5 km			Stone's tests P values	
	O	E	O/E (95% CI)	O	E	O/E (95% CI)	Unconditional	Conditional
All cancers	308	247·7	1·24 (1·11 to 1·39)	9196	8872·3	1·04 (1·02 to 1·06)	0·001	0·001
Brain neoplasm†	3	6·2	0·48 (0·10 to 1·41)	200	205·6	0·97 (0·84 to 1·12)	0·93	0·86
Stomach and pancreatic	27	26·9	1·01 (0·66 to 1·46)	1038	970·2	1·07 (1·01 to 1·14)	0·21	0·84
Lung	88	60·1	1·46 (1·17 to 1·80)	2383	2168·9	1·10 (1·06 to 1·14)	0·001	0·001
Skin melanoma	5	2·2	2·23 (0·72 to 5·20)	95	75·2	1·26 (1·02 to 1·54)	0·09	0·38
Colorectal	39	27·9	1·40 (1·00 to 1·91)	1053	1019·0	1·03 (0·97 to 1·10)	0·05	0·03
Prostate	19	12·6	1·51 (0·91 to 2·36)	500	465·5	1·07 (0·98 to 1·17)	0·02	0·26
Breast (female)	30	26·8	1·12 (0·76 to 1·60)	943	940·2	1·00 (0·94 to 1·07)	0·71	0·49
Non-cancer	745	656·1	1·14 (1·06 to 1·22)	25507	24936·2	1·02 (1·01 to 1·04)	0·001	0·001

*Expected cases adjusted for age, sex, socioeconomic deprivation, and regional standardised registration ratio.
†Malignant, benign, and unspecified tumours of the central nervous system.

Table 4   Mortality from selected cancers by distance from the PBI plant, 1981–92: all ages, both sexes

Outer radius of band (km)	All cancers			Brain neoplasms*			Stomach and pancreas			Lung			Melanoma skin			Colorectal			Non-cancers	
	O	O/E†	PMR	O	O/E	PMR	O	O/E	PMR	O	O/E	PMR	O	O/E	PMR	O	O/E	PMR	O	O/E
1	308	1·24	1·08	3	0·48	0·44	27	1·01	0·83	88	1·46	1·18	5	2·23	1·55	39	1·40	1·20	745	1·14
2	322	1·18	1·02	5	0·81	0·70	34	1·14	0·98	104	1·46	1·32	1	0·45	0·28	32	1·05	0·91	785	1·07
3	717	1·04	1·00	15	0·92	0·87	83	1·11	1·03	212	1·16	1·10	9	1·58	1·15	75	0·99	0·95	1846	1·00
4·3	1200	1·05	0·97	30	1·11	1·07	128	1·03	0·93	301	1·04	0·94	13	1·34	1·01	159	1·24	1·15	3319	1·05
5·3	1033	0·99	0·99	23	0·92	0·93	122	1·07	1·05	302	1·14	1·10	10	1·12	0·87	89	0·76	0·76	2699	0·95
6·1	1431	1·03	1·01	27	0·82	0·91	146	0·97	0·89	348	1·08	0·96	18	1·45	1·25	179	1·10	1·07	4253	1·07
6·8	2150	1·03	1·00	54	1·15	1·22	261	1·14	1·07	508	1·01	0·91	20	1·16	0·92	228	0·94	0·91	6099	1·02
7·5	2035	1·01	1·00	43	0·96	1·02	237	1·08	1·03	520	1·10	1·00	19	1·13	0·95	252	1·07	1·08	5761	1·00
Stone's tests P values:																				
Unconditional	0·001			0·93			0·21			0·001			0·09			0·05			0·001	
Conditional	0·001	0·33		0·86	0·92		0·84	0·95		0·001	0·003		0·38	0·52		0·03	0·30		0·001	

*Malignant, benign, and unspecified tumours of the central nervous system.
†Observed/expected ratio adjusted for age, sex, socioeconomic deprivation, and regional standardised registration ratio.

cancer there was some evidence of a decline in risk with distance (P = 0·001 unconditional test, P = 0·06 conditional test, tables 1 and 2), especially in the later period, 1982–9 (P = 0·001 and P = 0·01), when a 42% excess from 0–1 km was found based on 62 cases (O/E 1·42; 1·09 to 1·82, table 1).

Because of the overall excess in all cancers, the incidence (and mortality) of three additional common cancers were examined for descriptive purposes from 1977–89: colorectal cancer (ICD 153–154); prostatic cancer (ICD 185); and cancer of the female breast (ICD 174). There was an excess of prostate cancer from 0–7·5 km (O/E 1·10; 1·02 to 1·18); the combination of Stone's tests was not indicative of decline in risk with distance (P = 0·06 unconditional; P = 0·53 conditional, table 1).
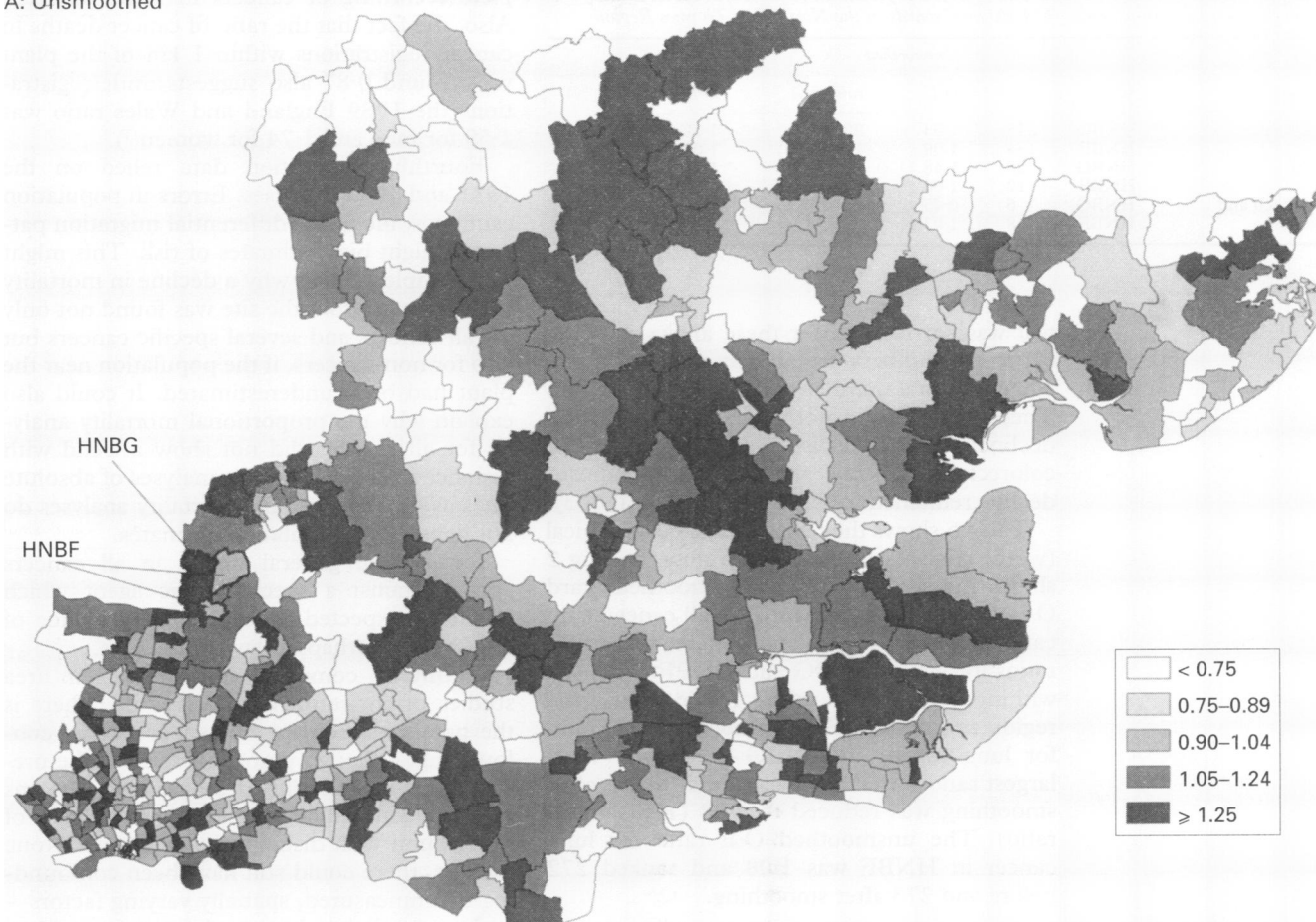
MORTALITY
From 1981–92, there were 9196 cancer deaths from 0–7·5 km (O/E 1·04; 1·02 to 1·06) and 308 from 0–1 km (O/E 1·24; 1·11 to 1·39, table 3). Within 1 km cancers of the lung (O/E 1·46; 1·17 to 1·80), colon and rectum, prostate, and breast, as well as melanoma of the skin, contributed to the excess in mortality from all cancers. As with cancer incidence, the overall excess was apparent for both sexes, and for the 15–64 and ≥ 65 age groups (not shown). From 0–7·5 km there was an excess of stomach and pancreatic cancer combined, lung cancer, and skin melanoma (O/Es ranging from 1·07–1·26). There was evidence of a decline in mortality with distance for all cancers, lung cancer (P = 0·001, unconditional and conditional Stone's tests for both), and colorectal cancer (P = 0·05 and 0·03, tables 3 and 4). There was also excess non-cancer mortality within 1 km of the site (O/E ratio 1·14; 1·06 to 1·22) and over 0–7·5 km (O/E 1·02; 1·01 to 1·04) with a significant decline with distance (P = 0·001, unconditional and conditional Stone's tests, tables 3 and 4).

Table 4 also shows the results of the proportional mortality analyses. Only one Stone's

A: Unsmoothed

HNBG

HNBF

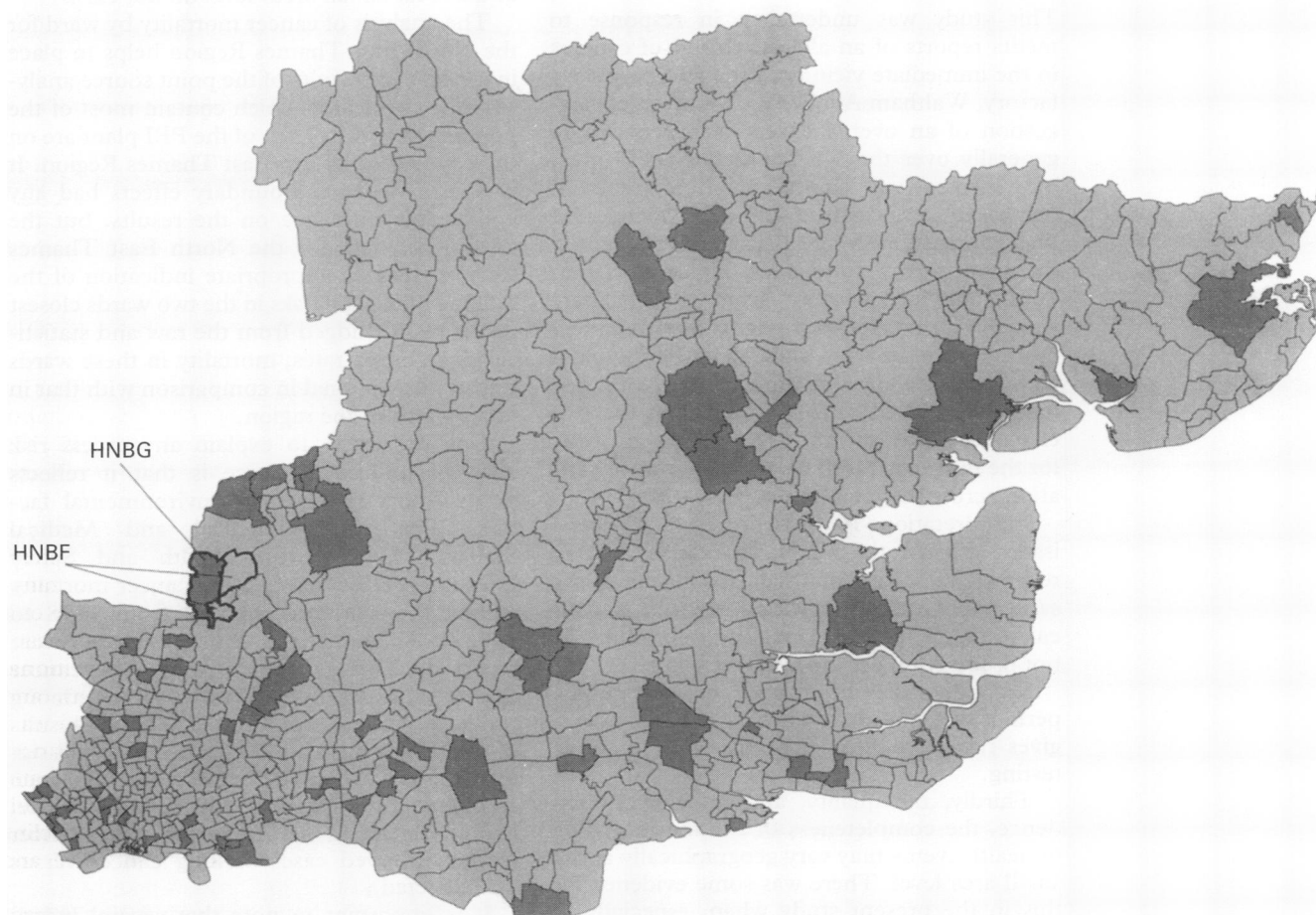|	
	< 0.75
	0.75–0.89
	0.90–1.04
	1.05–1.24
	≥ 1.25

B: Smoothed

HNBG

HNBF

Figure 2   Ward maps adjusted for age, sex and deprivation of O/E ratios for lung cancer mortality in the North East Thames Region, 1981–92.

Table 5 Observed cancer deaths and observed/expected ratios for wards HNBG and HNBF and their ranks among 601 electoral wards in the North East Thames Region

Cancer site	Ward	O	Unsmoothed		Smoothed	
			O/E	rank (%)	O/E	rank (%)
All cancers	HNBG	255	1·03	220 (36·6)	1·02	208 (34·6)
	HNBF	184	1·09	123 (20·5)	1·03	121 (20·1)
Lung	HNBG	28	1·48	42 (7·0)	1·08	16 (2·7)
	HNBF	12	1·00	272 (45·3)	1·00	273 (45·4)
Stomach and	HNBG	6	0·45	562 (93·5)	0·93	594 (98·8)
pancreas	HNBF	8	1·03	272 (45·3)	1·00	274 (45·6)

test was carried out for these analyses as the expected numbers are already constrained to equal the total number of cases within 7·5 km. These analyses did not suggest evidence of a decline in risk with distance for all cancers or colorectal cancers, although a significant decline remained for lung cancer (P = 0·003).

Table 5 shows the results of the geographical (ward) analyses of cancer mortality, and fig 2 shows the unsmoothed and smoothed ward O/E ratios for lung cancer. For all cancers and cancer of the stomach and pancreas, the O/E ratios for wards HNBG and HNBF were well within the range of values found across the region as a whole. The unsmoothed O/E ratio for lung cancer in HNBG was 1·48 (42nd largest ratio out of the 601 wards) which after smoothing was reduced to 1·08 (16th largest ratio). The unsmoothed O/E ratio for lung cancer in HNBF was 1·00 and ranked 272 before and 273 after smoothing.

Discussion

This study was undertaken in response to media reports of an alleged cluster of cancers in the immediate vicinity of the PBI pesticides factory, Waltham Abbey. We found some suggestion of an overall excess of cancers more generally over the 7·5 km radius study area, but inconsistent evidence for a trend of decreasing risk with distance. Evidence for this, strongest for lung cancer, was apparent in the later period for cancer incidence (from 1982) and for mortality (from 1981). There was also an unexplained excess of non-cancer mortality within 1 km and 7·5 km of the plant with evidence of a decline in risk with distance. Results of cancer mortality in the two electoral wards around the factory site were, for the most part, well within the range of variation across the region as a whole.

Interpretation is complicated by several issues. Firstly, the study was carried out in response to reports of an alleged cluster at the same site. Under these circumstances, statistical testing is formally invalid as P values do not properly reflect the play of chance.

Secondly, the multiplicity of end points, periods etc, not all of which are independent, gives rise to additional problems of multiple testing.

Thirdly, the quality, and for cancer incidence, the completeness of routine recording of health events may vary geographically at the small area level. There was some evidence for this in the present study when, especially in the earlier years, there was apparent incom-

plete recording of cancers in some districts. Also, the fact that the ratio of cancer deaths to cancer registrations within 1 km of the plant was around 0·87 also suggests underregistration (the 1989 England and Wales ratio was 1·59 for men and 1·74 for women[14]).

Fourthly, population data relied on the 1981 and 1991 censuses. Errors in population estimates, including differential migration patterns, might bias estimates of risk. This might for example explain why a decline in mortality with distance from the site was found not only for all cancers and several specific cancers but also for non-cancers, if the population near the plant had been underestimated. It could also explain why the proportional mortality analysis for all cancers did not show a trend with distance in contrast to the analyses of absolute rates as the proportional mortality analyses do not depend on population estimates.

Fifthly, the general excess in all cancers argues against a specific toxic agent which might be expected to affect the incidence of only one or perhaps a few cancer sites.

Sixthly, in common with other small area studies of environment and health,[5 8] there is the potential problem of socioeconomic confounding, although perhaps less so in the present study because the area near the plant was relatively affluent, with little change in levels of deprivation with distance from the site. None the less, there could still have been confounding by unmeasured, spatially varying factors—such as variation in prevalence of smoking. Routine sources of data on smoking patterns at the local (small area) level do not exist.

The analysis of cancer mortality by ward for the North East Thames Region helps to place in context the results of the point source analysis. The two wards which contain most of the population within 1 km of the PBI plant are on the edge of the North East Thames Region. It is unclear whether boundary effects had any appreciable influence on the results, but the analysis of data for the North East Thames Region gives an appropriate indication of the ranking of relative risks in the two wards closest to the plant. Judged from the raw and statistically smoothed rates, mortality in these wards was not exceptional in comparison with that in other wards in the region.

One possibility to explain any excess risk near an industrial source is that it reflects occupational rather than environmental factors. The Epidemiological and Medical Statistics Unit of the Health and Safety Executive (HSE) has studied cancer mortality among the workforce at PBI from 1978 to 1992.[15] Altogether 13 cancer deaths were reported. This compares with 308 cancer deaths reported here from 1981–92 among residents within 1 km of the plant. The results of the HSE study showed a small (but not significant) excess of all cancers among men employed for at least one year on the PBI site, mainly reflecting an excess of lung cancer (seven observed cases of lung cancer versus 2·5 expected).

It is important to note that several industries have been located near the PBI plant,

including some that have now closed. The company was established on the site of a former explosives factory, and less than 1 km to the north west and the south west lie two sites of the former Ministry of Defence Explosives Research and Development Establishment, which contain land reported to be contaminated with asbestos and other substances (D Perry, personal communication).

In summary, within the limitations of the small area approach and use of routine data the study provides limited and inconsistent evidence for a localised excess of cancer in the vicinity of the PBI plant. Although there was a small general increase in risk over the wider 7·5 km study area, and a decline in incidence of lung cancer and mortality with distance from the plant, increased risk and decline in risk with distance were also found for non-cancer mortality, which argues against a specific cancer hazard. For cancer mortality in the innermost wards, the findings were, for the most part, well within the range of variation across the region as a whole. At present, further investigation of this alleged cluster does not seem to be warranted, although surveillance of mortality and cancer incidence in the locality as a whole would indicate whether or not the apparent excess risk of disease persists.

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